Breeding Season Food Habits of Burrowing Owls in South-Central Montana

Denver W. Holt, Owl Research Institute, P.O. Box 39, Charlo, MT 59824
William D. Norton, Owl Research Institute, P.O. Box 39, Charlo, MT 59824
Eric C. Atkinson, Marmot's Edge Conservation, 4580 East Baseline, Bozeman, MT 59714

Abstract

We studied the diet of the burrowing owl (*Speotyto cunicularia*) during the breeding season in south-central Montana from 1990 to 1992. One thousand, eight hundred, ninety-six pellets, and various prey remains yielded 2497 prey items. Of these, 72.2 percent were small mammals with prairie voles (*Microtus ochrogaster*) most dominant. Mice (*Peromyscus* spp.) were the second most numerous prey eaten. Insects were difficult to quantify from pellets and likely were under-represented in the sample. Few amphibians and birds were eaten. Prey ranged in size from <1-g insects, to 104-g northern pocket gophers (*Thomomys talpoides*) with most vertebrate prey weighing about 35 g.

Key words: breeding season, burrowing owl, diet, Montana, *Speotyto cunicularia*

Introduction

The burrowing owl (*Speotyto cunicularia*) is widely distributed in dry prairie grasslands, steppes, deserts, and some agricultural areas throughout North America (Haug et al. 1993, Holt et al. 1999). Its breeding season diet has been well documented in the prairies of the United States and Canada, e.g., North Dakota (Konrad and Gilmer 1984), Oregon (Gleason and Craig 1979), South Dakota (McCracken et al. 1985), Wyoming (Thompson and Anderson 1988), and Saskatchewan (Haug 1985). Prior to our study we found no comparable data for Montana although a recent study conducted over a single breeding season in 1998 (Restani et al. in press) provided some comparative information.

Throughout much of its range in North America, burrowing owl populations appear to be in decline although specific reasons remain unknown (Haug et al. 1993, Holt et al. 1999). Collectively, a number of factors that may have contributed to this decline have been offered (Grant 1965, Coulombe 1971, Thomsen 1971, Zarn 1974, Wedgwood 1978, Collins 1979, James et al. 1997, Schmutz 1991, Haug et al. 1993). These include: conversion of native habitat to agriculture and human habitation; extermination of fossorial mammals that provide prey and nest sites; pesticides; mining; and some sport shooting among other factors. Similar declines have also been noted for many other species of grassland birds (Robbins et al. 1986).

In 1984 Montana Fish Wildlife and Parks (MFWP) identified the burrowing owl as a species of special concern (Montana Fish Wildlife and Parks 1984). In 1990 and continuing through 1992, we examined the diet of burrowing owls in south-central Montana during the breeding season. Our objective was to collect baseline data on the burrowing owl diet from Montana for comparison with results from other studies in the northern prairies. In 1998 MFWP, USDI Bureau of Land Management (BLM), Owl Research Institute (ORI), Marmot's Edge Conservation (MEC), and others initiated the state's first surveys to ascertain the status of burrowing owls in Montana.

Study Area

We surveyed Hailstone and Half-breed National Wildlife Refuges and surrounding sites, Stillwater County, south-central Montana, for burrowing owls during May-October 1990, 1991 and 1992. The National Wildlife Refuges were characterized as short-grass prairie, dominated by native grasses with a few shrubs and alkaline ponds. Study sites outside the refuges contained a mixture of native and introduced grasses. Intensity of cattle grazing varied among years. All sites had a mixture of black-tailed prairie dog (*Cynomys ludovicianus*), Richardson's ground squirrel (*Spermophilus richardsonii*), and American badger (*Taxidea taxus*) burrows scattered throughout. Ambient temperatures ranged from 7.7 to 37.3 EC, (0 = 9.3 EC) and precipitation averaged 5.9 cm per month (NOAA 1990, 1991, 1992). Soils were characterized as loams (USDA 1980), and elevation ranged from 1207 to 1258 m.

Methods

Burrowing owl pellets and prey remains were collected at nest burrows and roost sites twice/week. Pellets were teased apart by hand to separate, quantify, and identify prey.

Prey remains and carcasses also were identified and quantified using various methods described below.Mammals were identified to species using skulls, mandibles, and dental characteristics (Hoffmann and Pattie 1968). Voles were identified to species based upon dental characteristics where practical. Otherwise, we noted voles under the unidentified *Microtus* category. Two species of mice (*Peromyscus* spp.), which are almost identical in size, pelage, dental, and cranial characteristics (Hoffmann and Pattie 1968, Burt and Grossenheider 1976, Foresman 2001), occur in the study area. Because these traits are only detectable on recently captured animals, well-preserved specimens, or skulls, we did not differentiate these to species among prey items.

Birds were identified to species by comparing feathers, feet, skulls, and mandibles at the Philip L. Wright Vertebrate Museum, University of Montana, Missoula. Those not identified were placed in an unidentified category. While some pellets were composed entirely of feathers, we could not quantify the number of birds eaten. Rather, most birds were found as carcasses at nests or roost sites. Identification of amphibians to species followed Thompson (1982) and Stebbins (1986).

We identified insects to family (Borror and White 1970, White 1983). Insects were not quantified or identified since we did not collect insect remains in 1990 although we counted the number of pellets that contained predominately insect remains. In 1991 and 1992 we attempted to count the number of insects among pellets and remains of exoskeletons found at nest burrows and roost sites. We used heads, thoraxes, abdomens, legs, and wings to count insect prey.

We made every attempt not to duplicate the counting of prey by matching or pairing body parts of vertebrate or insect prey. We used a conservative approach in tallying the total numbers. We estimated prey body mass by using <1 g for insects and the mid-point of the range for mammals. We used the mid-point (see Burt and Grossenheider 1976) because of inconsistencies in mean body mass of prey reported in the literature, and because age differences among prey species are not always delineated (see Holt et al. 1991, Blem et al.1993). Furthermore, depending on the size of the owl and the prey, not all prey body parts are eaten, i.e., head, legs and wings of birds (see Holt 1994, Holt and Petersen 2000). Because of difficulty in assigning specific pellets to individual pairs of owls, we combined the prey for a general overview.

Results

Seasonal Diet within Years

In 1990 411 pellets and various prey remains yielded 963 vertebrate prey items from six breeding pairs and one individual owl. Small mammals accounted for 98.7 percent of that prey. Collectively, voles accounted for 85.6 percent ($n = 825$) of the prey with prairie voles accounting for 29.9 percent ($n = 288$) (Table 1). Mice were the second most abundant prey representing 12.5 percent ($n = 120$) (Table 1). There were highly significant differences among the proportions of the four species of mammals eaten ($X^2 = 437$, df = 3, $P < 0.001$) as prairie voles dominated the diet. Because so few other vertebrate prey species were eaten, they were not included in the analysis. Insect remains were found in 313 (76.2%) of the 411 pellets. A few horned larks (*Eremophila alpestris*) and tiger salamanders (*Ambystoma tigrinum*) represented birds and amphibians in the diet.

In 1991, 118 pellets and various prey remains yielded 218 prey items from seven breeding pairs. Small mammals accounted for 66.5 percent of that prey. Collectively, voles accounted for 55.5 percent ($n = 121$), of the prey with prairie voles accounting for 42.2 percent ($n = 92$) (Table 1). Mice were the second most common prey representing 8.3 percent ($n = 18$; Table 1). Differences among the proportions of the four species of mammals among pellets were highly significant ($\chi^2 = 174$, df = 3, $P < 0.001$) as prairie voles dominated in the diet. Because so few other vertebrate prey species were eaten, they were excluded from our analysis. Fifty-one (43.3%) of 118 pellets contained insect remains that accounted for 32.1 percent ($n = 70$) of the diet. Scarab beetles dominated followed by ground

Table 1. Burrowing Owl prey items collected from central Montana in 1990, 1991, and 1992.

	1990 (%)[a]	1991 (%)	1992 (%)	Total (%)
Mammals				
Prairie vole	288 (29.9)	92 (42.2)	538 (40.9)	918 (36.8)
Meadow vole	33 (3.4)	4 (1.8)		37 (1.5)
Vole spp.	504 (52.3)	25 (11.5)	71 (5.4)	600 (24.0
Mice spp.	120 (12.5)			
Northern pocket gopher	5 (0.5)	6 (2.8)	17 (1.3)	28 (1.1)
Subtotal	950 (98.7)	145 (66.5)	708 (53.8)	1803 (72.2)
Birds				
Horned lark	4 (0.4)	2 (0.9)	10 (0.8)	16 (0.6)
Western meadowlark			2 (0.2)	2 (0.1)
Chestnut-collared longspur			3 (0.2)	3 (0.1)
Unidentified	3 (0.3)		21 (1.6)	24 (1.0)
Subtotal	7 (0.7)	2 (0.9)	36 (2.7)	45 (1.8)
Amphibians				
Boreal chorus frog			1 (0.1)	1 (0.1)
Tiger salamander	6 (0.6)	1 (0.5)	5 (0.4)	12 (0.5)
Subtotal	6 (0.6)	1 (0.5)	6 (0.5)	13 90.5)
Insects				
Coleoptera				
Caribidae (ground beetles)		19 (8.7)	5 (0.4)	24 (1.0)
Scarabeaidae (scarab beetles)		33 (15.1)	17 (1.3)	50 (2.0)
Silphidae (carrion beetles)			8 (0.6)	8 (0.3)
Orthroptera				
Acrididae (short-horned grasshoppers		18 (8.3)	498 (37.8)	516 (20.6)
Subtotal		70 (32.1)	566 (43.0)	636 (25.5)
Total	963	218	1316	2497

[a] The column of parentheses is percent of prey from the grand total.

beetles and short-horned grasshoppers.

In 1992 1367 pellets and various prey remains yielded 1316 prey items from 17 breeding pairs and two single adults. Small mammals accounted for 53.8 percent of the prey. Collectively, voles accounted for 46.3 percent (n = 609) of the prey, and prairie voles accounted for 40.9 percent (n = 538) (Table 1). Mice represented 6.2 percent (n = 82) (Table 1). Differences among proportions of the four species of mammals eaten were highly significant (X^2 = 1224, df = 3, $P < 0.001$) as prairie voles continued to dominate the diet. Because so few other vertebrate prey species were eaten, they were not included in the analysis. Interestingly however, two western meadowlarks (*Sturnella neglecta*) were eaten. Insect remains occurred among 719 of 1367(52.6%) pellets and made up 43.0 percent (n = 566) of which short-horned grasshoppers accounted for 37.8 percent (n = 498) followed by scarab beetles.

Seasonal Diets Across Years

Of 2497 prey recorded from 1896 pellets and various prey remains collected during 1990-1992, mammals clearly dominated among prey eaten. Cumulatively, small mammals accounted for 72.2 percent (n = 1803) of the total prey over the three seasons. Numerically, prairie voles were the abundant item among pellets followed by mice (χ^2 = 96.14, df = 6, $P< 0.001$). All other vertebrates were eaten in numerically insignificant proportions (Table 1). Insects were most often identified from remains found at the nests and roosts but were commonly eaten and in large numbers when quantified in 1991 and 1992. Pellets that were made up of predominately insect remains were fragile and when teased apart were generally a conglomerate of small bits of chitin with few identifiable parts. Although tiger salamanders were brought to nests, interestingly, they apparently were not fed upon.

Prey items ranged in body mass from <1-g insects to 104-g northern pocket gophers (*Thomomys talpoides*). Voles occurred most frequently among vertebrate prey and dominated overall biomass. The prairie vole weighed about 35 g and meadow vole about 49 g. Mice weighed about 24 g and the Northern Pocket Gopher about 104 g. Although these estimates of body mass are conservative, they probably overestimate the actual size of free-ranging individuals among various sex and age classes, and thus, skew biomass estimates.

Discussion

Our results generally agree with those from others reporting on the burrowing owl diet. Prey availability, vegetative cover, and weather among other variables might influence annual and seasonal variation in the diet of burrowing owls (Thomsen and Anderson 1988, Haug et al. 1993). Gleason and Craig (1979) and Green (1983) reported that burrowing owls ate rodents in early spring and switched to insects as they became available. Schmutz (1991) also suggested that small mammals and insects are very important to burrowing owls in Alberta. Insects were the most numerous prey reported from other burrowing owl studies as well although small mammals dominated by biomass (Maser et al. 1971, Marti 1974, Konrad and Gilmore 1984, Haug 1985, Rich 1985, Brown et al. 1986). Seasonal variation in prey use also might be attributed to different stages of brood development and nutritional needs (Haug and Oliphant 1990, Thomsen 1971).

In Montana Restani et al. (in press) identified insects to family and found them numerically dominant in the burrowing owl diet whereas vertebrates dominated by biomass. Our results for the three most abundant insect families (acrididae, carabidae, scarabaeidae) followed a similar pattern and suggested these insect families are important to Montana burrowing owls. Greater numbers of insect families reported by Restani et al. (in press) probably reflected involvement of an entomologist for insect identification. Few small mammal prey reported by Restani et al. (in press) might reflect regional differences in burrowing owl diet, the manner in which prey were quantified, or simply only one season of study. Prey biomass for birds and Richarson's ground squirrel as reported by Restani et al. in (press) could be misleading if the entire body mass of these individuals was calculated. Our observations suggested that entire carcasses of birds and large mammalian prey are rarely eaten.

Although we had difficulty quantifying insects, we felt that small mammals probably were more important to these burrowing owls, particularly when considering mammal biomass. Our data also suggested that food habit studies only utilizing pellets may not truly represent numbers or species of insect prey eaten because pellets composed of insects often are flakes of chitin that break down rather quickly in the environment. This was consistent with findings of Thomsen (1971) who stated that burrowing owls pick at their food that results in pellets that are poor indicators of prey eaten. Coulombe (1971) reported that pellets containing fur preserved longer than those comprised of insect chitin. In contrast Marti (1974) felt that pellets did accurately reflect prey eaten even though many were badly broken or crushed. However, we believe that while pellet remains sufficed for vertebrate prey, they did not accurately reflect total numbers of insects eaten.

Acknowledgements

We thank Harold Blattie, John Foster, and Vicki Hert for field help on this project. We dedicate this paper to the late Roger Fliger, of the Montana Department of Fish Wildlife and Parks for his interest and assistance in this project. Dennis Flath provided vast knowledge of Montana burrowing owls and prairie dogs, and much encouragement. Mike Maples made helpful comments on earlier drafts of the manuscript. Marco Restani and anonymous referee made helpful suggestions also.

Literature Cited

Blem, C. R., L. B. Blem, J. H. Felix, and D.W. Holt. 1993. Estimation of body mass of voles from crania in short-eared owl pellets. American Midland Naturalist 129:282-287.

Borror, D. J., and R. E. White. 1970. A field guide to the Insects. Houghton Mifflin Co., Boston, MA.

Brown, B. A., J. O. Whitaker, T. W. French, and C. Maser. 1986. Note on the food habits of the screech owl and burrowing owl in southeastern Oregon. Great Basin Naturalist 46:421-426.

Burt, W. H., and R. P Grossenheider 1976. A field guide to the mammals. Houghton Mifflin Co., Boston, MA.

Collins, C. T. 1979. The ecology and conservation of burrowing owls: Their ecology and conservation: Symposium on the owls of the west. California Academy of Sciences, Tiburon, California pp 6-10.

Coulombe, H. N. 1971. Behavioral and population ecology of the burrowing owl, *Speotyto cunicularia*, in the Imperial Valley of California. Condor 73:162-176.

Foresman, K. R. 2001. The wild mammals of Montana. Special Publication No. 12, American Society of Mammalogists.

Gleason, R. L., and T. H. Craig. 1979. Food habits of burrowing owls in southeastern Oregon. Great Basin Naturalist 45:287-290.

Grant, R. A. 1965. The burrowing owl in Minnesota. Loon 37:2-17.

Green, G. A. 1983. Ecology of burrowing owls in the Columbia Basin, Oregon. Oregon State University, Masters thesis, Corvallis.

Haug, E. A. 1985. Observations on the breeding ecology of burrowing owls in Saskatchewan. University of Saskatchewan, Masters thesis, Saskatoon, Canada.

_____, and L. W. Oliphant. 1990. Movements, activity patterns, and habitat use of burrowing owls in Saskatchewan. Journal of Wildlife Management 54:27-35.

Haug, E. A., B. A. Millsap, and M.S. Martell. 1993. Burrowing owl (*Speotyto cunicularia*). *In* A. Poole and F. Gill, eds., The Birds of North America, No. 61. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologist's Union.

Hoffmann, R. S., and D. L. Pattie. 1968. A guide to Montana mammals. University Press, University of Montana, Missoula.

Holt, D.W., E. Andrews, and N. Claflin. 1991. Non-breeding season diet of northern saw-whet owls (*Aegolius acadicus*) on Nantucket Island, Massachusetts. Canadian Field-Naturalist 105:382-385.

_____. 1994. Effects of short-eared owls on common tern colony desertion, reproduction, and mortality. Colonial Waterbirds 17:1-6.

_____, R. Berkley, C. Deppe, P. L. Enriquez-Rocha, P. D. Olsen, J. L. Petersen, J. L. Rangel-Salazar, and K. Wood. 1999. Strigidae Species Accounts. Pp. 153-242 *in* J. del Hoyo, A. Elliot, and J. Sargatol, eds., The Handbook of Birds of the World, Vol. 5: Lynx Edicions, Barcelona, Spain.

_____, and J. P. Petersen. 2000. Northern pygmy owl (*Glaucidium gnoma*). *In* A. Poole and F. Gill, eds., The Birds of North America, No. 494. The Birds of North America Inc., Philadelphia, PA.

James, P. C., T. J. Ethier, and M. K. Toutloff. 1997. Parameters of a declining burrowing owl population in Saskatchewan. Journal Raptor Research 9:34-37.

Konrad, P. M., and D. S. Gilmore. 1984. Observations on the nesting ecology of burrowing owls in central North Dakota. Prairie Naturalist 16:129-130.

Marti, C. D. 1974. Feeding ecology of four sympatric owls. Condor 76:45-61.

Maser, C., E. W. Hammer, and S. A. Anderson. 1971. Food habits of the burrowing owl in central Oregon. Northwest Science 45:19-26.

McCracken, J. G., D. W. Uresk, and R. M. Hanson. 1985. Burrowing owl foods in Conata Basin, South Dakota. Great Basin Naturalist 45:287-290.

Montana Fish, Wildlife and Parks. 1984. Vertebrate Species of Special Concern, Helena, MT.

National Oceanic and Atmospheric Administration. 1990-1992. Climatological Data Annual Summaries, Billings, MT.

Rich, T. 1985. Habitat and nest site selection by burrowing owls in the sage-brush steppe Idaho. Bureau of Land Management Tech. Bull. 85-3, 1-14 pp.

Robbins, C. S., D. Bystrak, and P. H. Geissler. 1986. The breeding bird survey: Its first fifteen years. USDI Fish and Wildlife Service. Resource Publication 157.

Schmutz, J. K. 1991. Spring and summer prey of burrowing owls in Alberta. Blue Jay 49:93-97.

Stebbins, R. C. 1986. A field guide to western reptiles and amphibians. Houghton Mifflin Co., Boston, MA.

Thomsen, L. 1971. Behavior and ecology of the burrowing owl on the Oakland Municipal Airport. Condor 73:177-192.

Thompson, C. D., and S. H. Anderson. 1988. Foraging behavior and food habits of the burrowing owl in Wyoming. Prairie Naturalist 20:23-28.

Thompson, L. S. 1982. Distribution of Montana amphibians, reptiles and mammals. Th Montana Audubon Council, Helena.

United States Department of Agriculture. 1980. Soil Conservation Service Survey, Stillwater County, Montana, 1975.

Wedgwood, J. A. 1978. The status of the burrowing owl in Canada. A report prepared for the committee on the status of endangered wildlife in Canada. Canadian Wildlife Service, Ottawa.

White, R. E. 1983. A field guide to the beetles of North America. Houghton Mifflin Co., Boston, MA.

Received 10 March 2001

Accepted 26 October 2001

Zarn, M. 1974. Burrowing owl: Report No 11, Habitat management series for unique of endangered species. USDI Bureau of Land Management, Denver, CO.